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national records, but on the U.S. track and field road running records (1).

In conclusion, in this article, the incidence of SCDs was calculated from an uncertain number of events over an estimated number of athletes. The lack of solid numbers for both the numerator and denominator makes the death rates not reliable.

Moreover, we were surprised that results of the Israel screening program were completely ignored: no information was provided regarding the implementation of the national screening, the number of examined athletes, the proportion of disqualified ones, and the cardiac abnormalities discovered. In short, no data derived from the direct experience of sport physicians support the alleged inefficacy of the screening program in Israel.

By comparison, the Italian data were gathered according to a prospective study design with systematic investigation of all young individuals (competitive athletes and sedentary controls) who died suddenly. All of the hearts were examined according to a definite protocol by expert cardiovascular pathologists. Moreover, the number of competitive athletes registered within the athletic sport organizations and undergoing the pre-participation screening program was known for certain. The large diversity of Israel and Italian screening reports make their direct comparison inappropriate.

The Italian experience showed a significant decrease in mortality over the entire time period after the implementation of the screening program (p for trend <0.001), through analysis of the time trend of death rates with Poisson regression of the number of SCDs in each year against the calendar year, including the log of the amount of person-time at risk in each year as an offset term. Poisson regression analysis of the mortality trend over 26 years allowed the potential limitation of a relatively short pre-screening period to be overcome.

Indeed, the comparison of the SCD trend between screened athletes and unscreened nonathletes (i.e., a control population of the same age from the same geographic area) during the same study period provided compelling evidence of the selective decrease in mortality in young athletes undergoing screening.

Although the authors' aim to explain the trend of SCDs in Israel athletes is laudable, their conclusion that the mortality rate in young athletes cannot be changed by implementing pre-participation screening is not supported by scientifically reliable data.

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Media Reporting Bias Affects Reported Sudden Death Rates

Steinvil et al. (1) are to be commended for bringing an important problem into the spotlight. In the past 3 weeks in the United States alone, there have been 5 deaths of student athletes. The current practice of pre-participation history and physical examination does not detect most of the athletes at risk of sudden cardiac death (SCD). However, rather than give us guidance on how to identify high-risk athletes, Steinvil et al. (1) have raised more questions.

First, their study is based on observational data and retrospective analysis, which are appropriate for generating hypotheses but not for drawing significant conclusions or recommending policy changes. Furthermore, the data used were newspaper/media reports, which have inherent limitations and could lead to information bias. For instance, the deaths of less-successful athletes may be under-reported in the media. It is unclear why the authors did not use a more complete source for mortality data, such as the National Center of Forensic Medicine, which was used for a previous similar study in Israel (2).

Furthermore, the deaths reported in this study were only for competitive athletes. The benefit of pre-participation screening may lie among those who engage in physical activity on a noncompetitive level, but such persons were excluded in this analysis. Although Steinvil et al. (1) acknowledged this limitation, they did not estimate its effects. In most populations, this cohort is actually larger than the professional athletes. For instance, in a report on SCD from 1974 to 2002 in the Israel military, there were 74 cases of SCD among Israeli soldiers ages 18 to 39 years (3). These cases were not reported in the media, and yet these cases represent young persons who were engaged in physical activity who died suddenly.

Contrary to what Steinvil et al. (1) reported, the previous large Italian study of SCD in school-age athletes (4) was a prospective study, not a retrospective study, with superior sources of outcomes data. Steinvil et al. (1) concluded that the results of the Italian study were related to a natural variation in SCD incidence rates. However, in the Italian study, incidence rates of SCD were also collected for the unscreened nonathletic young population, and this rate remained constant over the 25 observation years. We think that it is more likely that the marked variation noted in the incidence of SCD in the Steinvil et al. study is due to the source of their data (i.e., that media reporting is related to what is currently in "vogue" and that this reporting may not reflect the true population incidence rate).

We agree with Steinvil et al. (1) that to prevent SCD in this young population, we need to strive for a solution that is feasible and cost-effective. However, we believe that we cannot continue with the status quo. Young athletes continue to die suddenly, and we need to do better with identifying persons at risk. We believe that the solution will require new thinking, and we join the authors in a call for further studies on this serious societal concern.

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Reply

Drs. Pelliccia and Corrado as well as Dr. Higgins and colleagues correctly point out that the use of media reports as the sole source of data in our study (1) may have led to an underestimation of the true incidence of arrhythmic death among athletes in Israel. However, the mean annual incidence of sudden death/cardiac arrest events in our study (1) (2.6 events per 100,000 athlete-years) was within the range of event rates reported in Italy (2), the United States (3), and Denmark (4).

Dr. Higgins and colleagues also question why we failed to use the National Center of Forensic Medicine as a source for more complete data and quote a study by Yanai et al. (5) using that methodology in Israel. Regrettably, forensic examinations are performed in only a minority of fatalities in Israel. Nevertheless, 2 points are worth emphasizing: 1) In the study by Yanai et al. (5), more than one-half of the deceased athletes undergoing forensic examination had previously been found "fit to participate in active sports" (again emphasizing the limitations of screening) (5); and 2) in Denmark, where forensic examination is actually mandatory after unexpected death (4), the incidence of sudden death among athletes is strikingly similar to that reported for Italy even though electrocardiographic (ECG) screening is not routinely performed in Denmark, whereas it is mandatory in Italy (2,4).

Countries considering implementation of mandatory ECG screening of athletes should take a close look at the performance of such a strategy in Israel to learn how not to do it. In Israel, no information is collected about the number of athletes undergoing (often unnecessary) additional diagnostic tests or about the number of athletes who have been disqualified since the implementation of the law mandating screening.

Our study is important because it compared pre-screening and post-screening periods of similar duration. This is in contrast to the study by Corrado et al. (2), which showed an impressive reduction in the sudden death rate of athletes in the post-screening period using for comparison a pre-screening period of only 2 years' duration (Fig. 1A). Had we used the same strategy, we would have also erroneously concluded that mass screening of athletes with an electrocardiogram saves lives (Fig. 1B). Only when comparing the post-screening period with a pre-screening period of similar duration (Fig. 1C) one realizes that the apparent "reduction in cardiac-arrest rates," which would otherwise be entirely credited to ECG screening, was made possible by the increase in sudden death rates that preceded the initiation of screening.

Given the important limitations of our study, correctly emphasized by Drs. Pelliccia and Corrado, we do not claim that ECG screening is futile. However, we do maintain that the benefit of ECG screening for the prevention of sudden death in

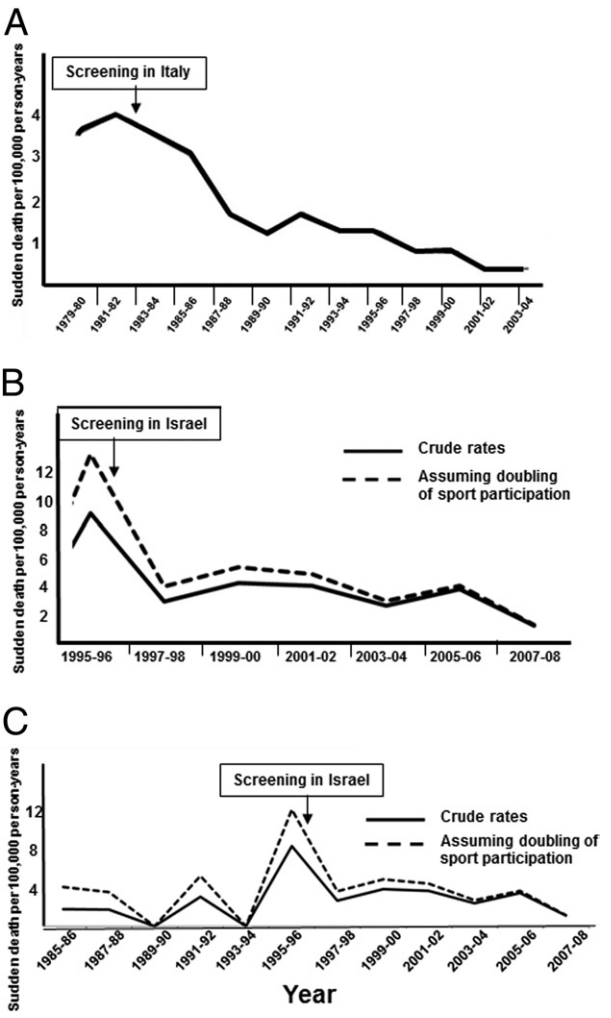

Figure 1 **Annual Incidence of Sudden Death per 100,000 Person-Years Among Competitive Athletes Before and After the Initiation of Mandatory Electrocardiographic Screening**

(A) Results for Veneto, Italy (modified from Corrado et al. [2]). **(B)** Results for Israel. Note how similar the graphs of the 2 studies are when the post-screening period is compared with a 2-year pre-screening period. **(C)** Results for the entire Israeli study (1).